

APPENDIX A: Research and Development

FWS Fisheries Program Research and Development Funding (\$000)			
	FY 2008 Enacted	FY 2009 Enacted	FY 2010 Request
National Fish Hatchery System Subactivity			
Fish Technology Centers (FTC)	6,321	6,321	6,321
FTC's provide leadership in science-based management of trust aquatic resources through the development of new concepts, strategies, and techniques to solve problems in hatchery operations and aquatic resource conservation.			
Fish Health Centers (FHC)	4,061	3,588	3,588
FHC's provide the information needed to insure the health of aquatic species within the ecosystems managed by the Service; Provides fish health biologists with access to training, experience, and a network of highly trained specialists and researchers; Evaluates all aspects of the ecosystem that can alter the health of aquatic animals; Integrates many disciplines to provide comprehensive recommendations to managers; Promotes the health of wild stocks and addresses the effects of hatchery operations on natural fish populations.			
Fish & Wildlife Management Assistance Subactivity			
Conservation Genetics Lab (CGL)	731	731	731
The CGL provides genetic analysis support and expertise to fishery managers for the purpose of conserving genetic resources.			
Aquatic Invasive Species Subactivity	0	0	156
The Service's AIS program contributes to maintaining sustainable native aquatic populations and recovering threatened and endangered populations by preventing the introduction and spread of aquatic invasive species, monitoring habitats to determine the distribution of invasive species, rapidly responding to new invasions, and controlling established invaders. The AIS program is committed to the implementation of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (as amended by the National Invasive Species Act of 1996) and the Injurious Wildlife Provisions of the Lacey Act.			
Total Fisheries Program Research and Development	11,113	10,640	10,796
Climate Change Science Capacity (\$000)	0	0	10,000
See Climate Change Section for details			

The FWS Fisheries program's applied research activities support on-the-ground needs of the Fisheries program and its partners. New research and technology needs are prioritized in accordance with goals and objectives of the Fisheries Strategic Plan. New initiatives are developed based on an analysis of needs in the Fisheries Operational Needs (FONS) on-line database that provides access to current applied research needs in "real time." Within the Fisheries Information System, applied research needs are linked with the corresponding Strategic Plan Objective, to the broader management plan that calls for the work (such as a Recovery Plan), and to a list of partners in support of the work, collectively establishing relevance for science support activities. Relevance is the first of the three Office of Management and Budget (OMB) R&D criteria.

While science is conducted throughout the Fisheries program, the seven Fish Technology Centers (FTC), nine Fish Health Centers (FHC), the Conservation Genetics Laboratory (CGL), and the Aquatic Animal Drug Approval Partnership (AADAP) program's laboratory all focus on providing applied research support to Fisheries program managers. In addition, the 65 Fish and Wildlife Conservation Offices (FWCO) across the nation not only provide science support to the Fisheries program, but they provide on-the-ground and in-the-water hypothesis testing and the application and field-testing of new scientific approaches - all contributing to an adaptive management approach to fisheries management. Performance is the second of the three OMB R&D criteria. These facilities contribute directly to the Fisheries

program's outcome measure "% of aquatic T&E populations that are self-sustaining in the wild", to several applied research performance measures (e.g., "# of techniques/culture technology tools developed"), and indirectly to the balance of Fisheries program performance measures, by providing fisheries biologists and managers with the necessary science support to successfully manage fishery resources. For example:

- The Lamar Fish Technology Center (PA) is developing a computer model, based on a quantitative assessment of stream morphology and biological data, that relates physical properties of trout streams to trout productivity. The model will soon be available to managers to guide future stream restoration efforts under the Eastern Brook Trout Joint Venture. In other modeling efforts, Lamar FTC has developed a horseshoe crab age structured population model to assess harvest and egg availability for shore birds (published in *Estuaries and Coasts*, Vol. 30:2). Lamar is finalizing a Structured Decision Making Model that will guide multi-State management (by the Atlantic States Marine Fisheries Commission) efforts to balance harvest with shore birds requirements (linking population dynamics of shore birds and horseshoe crabs).
- Until recently, little was known about the safety limits associated with standard therapeutic compounds (used to treat pathogens) for salmonids, especially threatened and endangered species reared for restorations and recovery (treatment regimes were based on rainbow trout). A study by the Abernathy Fish Technology Center (WA) determined safe treatment levels of five standard treatment compounds for three salmonid species, by fish size, providing hatchery managers with critical information for safe treatment regimes for coho, Chinook, and steelhead. This paper was published in the *North American Journal of Aquaculture* 70: 175-183.
- Use of genetic techniques can be a highly informative tool in understanding the connectivity of habitats through evidence of gene flow. The Lamar Fish Technology Center (PA) applies genetic techniques to assess the diversity of brook trout populations spatially throughout the Nash River, and above and below barriers. The application of this information to understanding the impact of culverts as barriers to brook trout movement in the Nash River is being used by managers to prioritize future culvert removal and habitat improvement.
- The endangered June sucker from Utah Lake and the Provo River are propagated for recovery stocking as part of the June Sucker Recovery Plan. Physiological studies at the Bozeman Fish Technology Center (MT) evaluated thermal requirements for propagation and determined an upper lethal temperature for larvae. As a result of this study, hatchery spawning methods for adults were refined, increasing spawning success from 53% to 90% of fish. This paper was published in the *North American Journal of Aquaculture*. New studies are under way to determine stress responses to culture practices, and to determine optimal larval and juvenile diets.

High quality science, supported by peer review (third OMB R&D criteria) is integral to the Fisheries program's science support programs. Fisheries personnel on the Service's Science Committee have been involved in efforts to develop publication and peer-review standards. Fish Technology Center quality assurance/quality control standards guide all applied research activities. Regular assessment of program quality and relevance is conducted via the Fish Technology Center Evaluation Program. The evaluations not only improve the accountability and quality of programs, but also identify program deficits and areas for improvement. The evaluation process now includes external partners and compares Service protocols to those of outside entities, to provide an objective review that demonstrates relevance to the broader fisheries management community. Fish Health Centers also use a standardized set of procedures and protocols for conducting fish health inspections at Service and partner facilities. These procedures and protocols undergo internal and external reviews to ensure the methods are both current and scientifically

valid. This is particularly important as global climate change and other challenges influence the discovery of many new organisms and the adaptation of other organisms to new and novel conditions.

As managers struggle with the environmental manifestations of global climate change such as drought conditions in the south, Fish Technology Centers provide “on the ground” science support for a myriad of related resource issues from genetic assessment of population isolation and temperature effects on reproduction to aquatic nuisance species. FTCs assist managers with experimental design and data analysis, problem solving and applied research support in areas such as population ecology, physiology, genetics, nutrition, and fish culture technology. In the realm of fish culture, FTC scientists work behind the scenes to improve methods and provide information needed to producing healthy, genetically diverse, and well-adapted fish that will succeed in meeting fishery management objectives. FTCs assist hatchery managers with responsible stewardship of adjacent streams and source waters through assistance with HACCP planning, development of water conservation and treatment technology, monitoring of contaminant levels in feed and hatchery products, and related issues that promote healthy ecosystems. FTCs share information through regional and national management councils and committees, and publish regularly in peer-reviewed journals.

Activities include:

- Application of genetic tools to characterize populations and assess diversity, as a basis for population management decisions and to provide information needed to develop genetic plans for hatchery propagation of imperiled species for restoration and recovery;
- Development of new tools and techniques for marking fish, both for population monitoring and for assessment and evaluation of hatchery programs;
- Development of modeling tools for management application such as habitat restoration and harvest management;
- Physiological studies on stress related impacts of global climate change;
- Development of culture techniques to minimize captive propagation influence on post stocking behavior of native threatened and endangered species;
- Development and use of cryopreservation techniques to more efficiently manage propagation programs and for long-term gamete preservation;
- Testing of alternative cultural practices to improve the quality and cost effectiveness of hatchery-produced fish and developing new propagation technology for imperiled species;
- Development of water and energy conservation “best management practices” for hatcheries;
- Determining nutrition requirements and improving diets of imperiled species for propagation;
- Dissemination of technical information to federal and state agencies and the private sector through scientific journals, professional meetings, and workshops;

Fish Health Centers provide service, expertise and information that assist in the development of management strategies through assessment and applied research to support the protection of wild stocks and restoration of threatened and endangered species. Comprehensive aquatic animal health requires:

- Monitoring, diagnostics, and inspections of aquatic animals including their physiological and biological characteristics;
- Understanding of the condition, individual requirements, and interactions of wild and cultured fish related to disease and aquatic health;
- Application of diverse scientific fields such as microbiology, fish biology, epidemiology, toxicology, pathology, physiology, histology, and genetics;
- Active representation in management through providing information, risk analysis and management alternatives for decision making; and,

- Education of priority publics about the value of comprehensive fish health in preventing catastrophic losses and improving survivability of aquatic species.

The Conservation Genetics Lab works with biologists and managers to design and conduct genetic research and provide expertise to address conservation and management issues on 16 National Wildlife Refuges in Alaska, and in other Fish and Wildlife Service Regions. Activities include:

- Providing information on the genetic characteristics of fish and other populations required for conserving biodiversity. This includes identifying individual populations, determining how they are related, and grouping them into appropriate management units; and,
- Applying the results of genetics research to the management of important subsistence, commercial and recreational fisheries to determine patterns of migration and run-timing, and the origin of fish harvested in mixed-stock fisheries to protect depleted populations while allowing the harvest of healthy ones.

The Fish and Wildlife Conservation Offices (FWCO) are uniquely suited to partner with our other Federal, State and Tribal partners to conduct critical population dynamics analysis that inform fisheries management actions, such as harvest limits, stock assessments, and viable population analysis, for threatened and endangered, native, and interjurisdictional aquatic species. Recovery and management of these species are dependent on this vital population-level information. Additionally, FWCOs provide important population-level information regarding the status of interjurisdictional fisheries to management entities such as the Great Lakes Fisheries Commission and the Atlantic and Pacific States Marine Fisheries Commissions.

The Fisheries program supports a modest team of hydraulic and hydrological engineers. These engineers form an interface of science and management for various watershed level fisheries activities, including the National Fish Passage program and National Fish Habitat Action Plan. The Fisheries program engineering expertise provides up-to-date state of the art design and project-level oversight the Service and our partners on the removal of dams, as well as the implementation of fishways, fishscreens, stream simulation fish passage, stream and river restoration projects.

The Fish and Wildlife Conservation Offices provide the on-the-ground services and technical expertise on the inventory, assessment, and monitoring of our federal trust aquatic species and their habitats. FWCOs identify and inform science needs, as well as develop, implement and utilize the best science available to manage native, threatened and endangered, and interjurisdictional fish and other aquatic species to self-sustaining populations. Fisheries science is an integrative approach to understanding the biology, ecology, and economics of a fished, listed, or interjurisdictional species with the goal of sustainable management. Activities include:

- Conducting stock assessment analyses to inform harvest limits, viable population sizes, and recovery goals for self-sustaining populations of federal trust species.
- Analyzing population levels and responses to environmental changes, such as Climate Change
- Using state of the art geographic information systems to inventory and map aquatic species habitat usage
- Evaluation of population structure and dynamics
- Conservation and restoration of riparian habitats using applied fluvial geomorphological techniques

The Aquatic Animal Drug Approval Partnership (AADAP) Program ensures continued progress towards obtaining FDA-approved and EPA-compliant new animal drug approvals for use in Federal, State, Tribal and private aquaculture programs throughout the United States. The AADAP program helps to lead a

coordinated national effort to generate data, disseminate information and data, and manage all other aspects of requisite data submissions to U.S. Food and Drug Administration (FDA) in support of new animal drug approvals for aquatic species. Activities include:

- Managing the National Investigational New Animal Drug (INAD) program to allow Service and non-Service fish culturists and fish health biologists legal access to drugs not yet approved by FDA;
- Developing compassionate INAD use protocols and obtaining slaughter authorization from FDA to allow for legal harvest/stocking of treated animals and interstate transport of INADs;
- Conducting controlled, replicated field studies to evaluate the safety of drugs on a variety of finfish species for specified claims;
- Conducting Good Laboratory Practices compliant studies to evaluate the safety of drugs on a variety of finfish species.
- Coordinating with drug sponsors, data generating partners, and FDA to effectively manage New Animal Drug Applications.

Although the Aquatic Invasive program's primary focus is prevention, timely, pertinent research is essential to the success of the program. Scientifically valid information about the taxonomy, life history and physiology of nonindigenous aquatic species, their effects on the environment and human activities, and their potential for becoming invasive is required for the multitude of decisions needed to refine and implement the program. In addition, biologically sound information is necessary to identify effective techniques for prevention, detection, monitoring, and control. The AIS program has supported research on:

- Modeling invasive species expansion with climate change
- Stock recruitment models for bighead carp
- Asian carp repellent and attractant pheromones
- Development of new techniques to detect DNA of reproducing zebra/quagga populations at very low levels
- Evaluating ecosystem effects of Asian carp
- Risks posed by parasites of alien mollusks
- Round goby range and distribution
- The extent of VHS expansion and species affected

The vast majority of the Service's Fisheries program resource management needs are addressed sufficiently through our internal applied science expertise. Where basic research is required to investigate underlying or fundamental biological, physical, or chemical considerations, we have a long history of working with USGS collaboratively.